Space Weather Technical Forecast

Issued on Sunday, 14 January 2024 at 13:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is at Low levels, with background irradiance also at C-class levels. The largest flare of the period was a C9.6 peaking at 14/1206 UTC, attributed to Ex-AR3538 beyond the northwestern limb. There are fourteen sunspots on the visible disc. Two large spots reside in the southeast, AR3545 and AR3549, these are both characterised by large leaders followed by small spots and pores of opposite polarities, the latter of which has developed a gamma configuration in it's trailing region. The most complex region appears to be AR3541 in the southwest, which is set amongst a larger complex of sunspots. There is evidence of magnetic looping between regions, which may result in greater instability. All other spots remain small or simple at present.

No CMEs observable on coronagraph imagery over the past 24 hours are expected to have an Earth-directed component.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as observed by DSCOVR at L1, have been indicative of background conditions perhaps with a weak transient arrival around 14/1715 UTC, though due to the lack of ACE observations to corroborate, confidence in specific parameters is low. Solar wind speeds are thought to be Slow/Ambient to Slightly Elevated, around 330-470 km/s. Density is thought to have been Average or below. The interplanetary magnetic field (IMF), Bt, has been weak throughout, at or below 7nT. The north-south component, Bz, was weak and mostly negative, fluctuating between +2/-7nT, though a more notable period of -Bz was observed beginning 14/0715 UTC. Phi angle has been positive (away from the Sun) throughout. Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux was at background levels.

GOES16 high energy (greater than 2MeV) electron flux was at background to moderate levels. The associated 24-hour fluence was well below Active (1e8 integrated pfu) throughout. The 13/0000 UTC 24-hour integrated fluence observation was 3.00e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a chance of isolated M-class activity throughout, and a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast. Wind speeds are expected to remain at similar levels, perhaps declining through days 1-2 (14-15 Jan). The high speed stream of CH92/+, with speeds of 450-500 km/s, may arrival late day 3 (16 Jan) or into day 4 (17 Jan).

Overall, geomagnetic activity is likely to be Quiet (Kp 0-2) throughout, but with a chance of Unsettled to Active (Kp 3-4) intervals on day 4 should we see any HSS influence.

Energetic Particles / Solar Radiation: High energy proton flux will most likely remain at background levels. Although, there remains an ongoing slight chance of seeing an increase to

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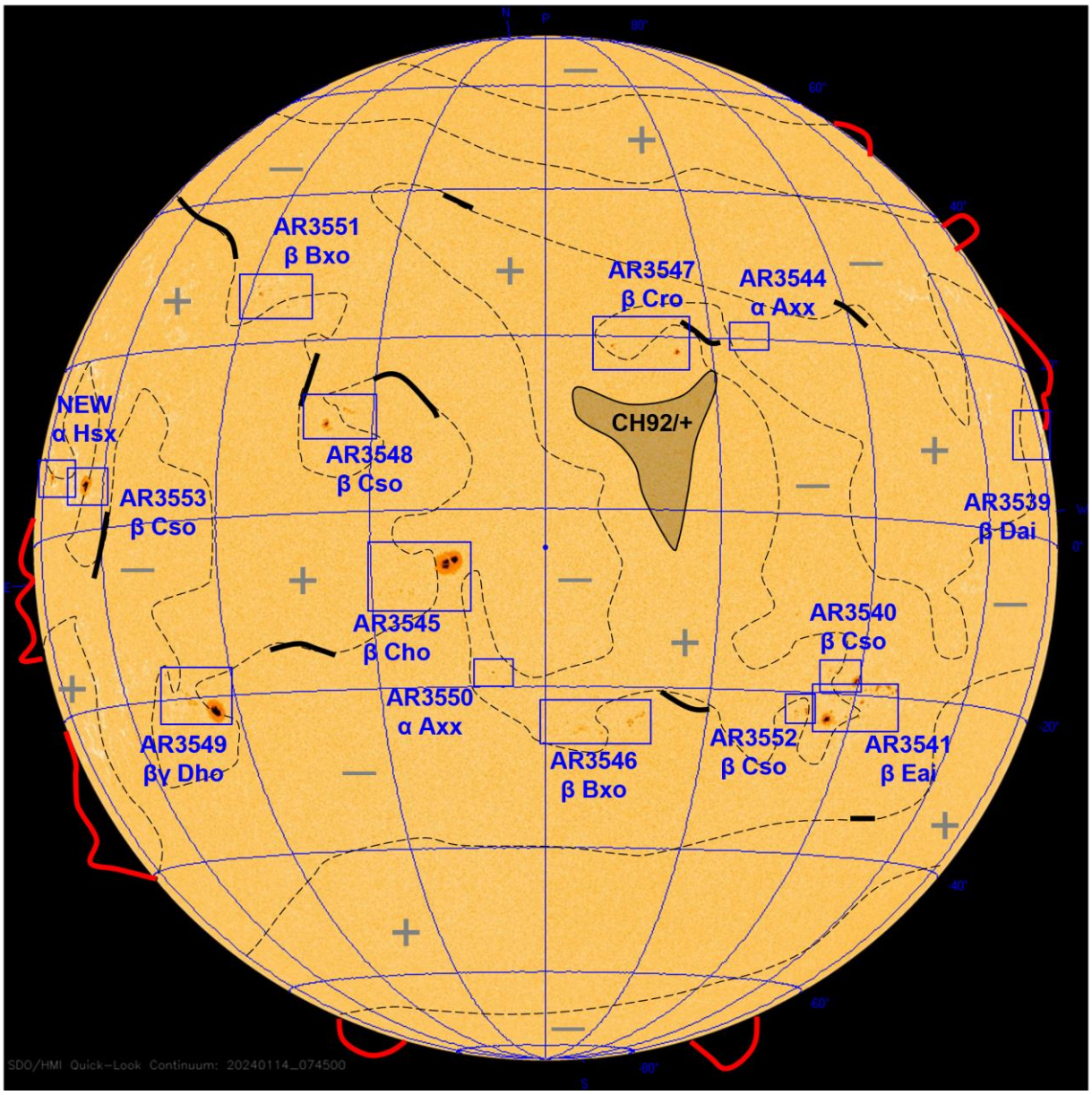
the S1/Minor Radiation Storm threshold, should any notable flares occur.

The high energy electron flux is forecast to persist at background levels, with fluence below Active through this period. There is a chance of slight enhancement from day 4 (17 Jan).

Figure 1. Solar Analysis Valid 14/0800 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs currently feature in the forecast.

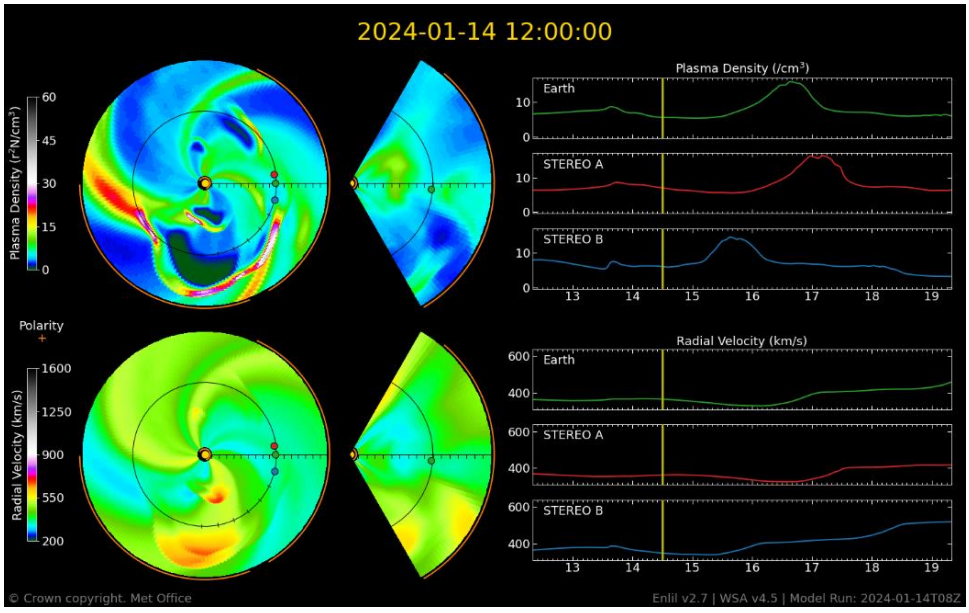
Wind speeds are currently around 450-480 km/s, and are expected to decline towards 400 km/s or ambient levels days 1-2 (14-15 Jan). The main feature of interest in the forecast period is CH92/+, currently centre disc in the northern hemisphere. This coronal hole is a persistent feature, but is much smaller and fainter than on the previous rotation, with the leading edge further East than last time around. Wind speeds in the High Speed Stream (HSS) reached above 600 km/s on the previous rotation, on the equivalent of Day 2 (15 Jan). However, the much reduced size of the coronal hole suggests slower wind speeds of 450-500 km/s, which combined with the change in location, gives a potential arrival time later day 3 (16 Jan) or perhaps into day 4 (17 Jan).

Recent Enlil runs support the idea of slight wind enhancement 16-18 Jan, with speeds of 400-450 km/s, largely representative of what is expected.

Overall, geomagnetic activity is likely to be largely Quiet (Kp 0-2), especially days 1-2 (14-15 Jan). There is a chance of Unsettled to Active (Kp 3-4) intervals from later day 3 (16 Jan) upon connection to the anticipated coronal hole HSS.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC ENLIL



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Radio Blackouts - X-Ray Flares:

Solar activity is at Low levels. The largest flare of the period was a C4.2 peaking at 14/0022 UTC, appearing to emanate from AR3539 near the northwest limb although it may have originated from Ex-AR3538 which is beyond the northwest limb.

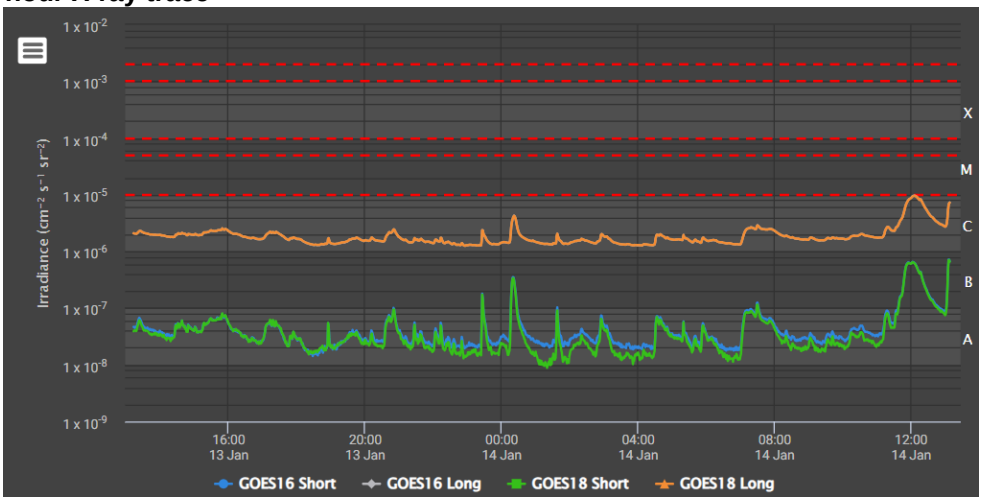
There are fourteen sunspots on the visible disc, one of which is unnumbered. AR3544 and AR3551 have both re-emerged as small and simple spots. AR3539 is in the process of rotating around the northwest limb, therefore it's previous analysis is conserved until this process has complete. Two large spots reside in the southeast, AR3545 and AR3549, these are both characterised by large leaders followed by small spots and pores of opposite polarities, the latter of which has developed a gamma configuration in it's trailing region. The most complex region appears to be AR3541 in the southwest, which is set amongst a larger complex of sunspots. There is evidence of magnetic looping between regions, which may result in greater instability than the raw probabilities suggest. All other spots remain small or simple at present.

Seismic analysis and recurrence would suggest that there are a number of regions which are due to return or rotate across the eastern limb through the period. This is supported by areas of brightness visible on EUVI/AIA 195 imagery suggesting the proximity of Carrington regions.

There is a chance of isolated M-flares throughout, with a slight chance of X-flares, perhaps most probable from the AR3541 region or AR3539 which is due to rotate off the disc during day 1 (14 Jan). There is an associated slight reduction in probabilities at this point, with an increase on day 4 (17 Jan) by which point a number of regions are expected to have rotated onto the disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	45	40	40	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: 24 hour X-ray trace



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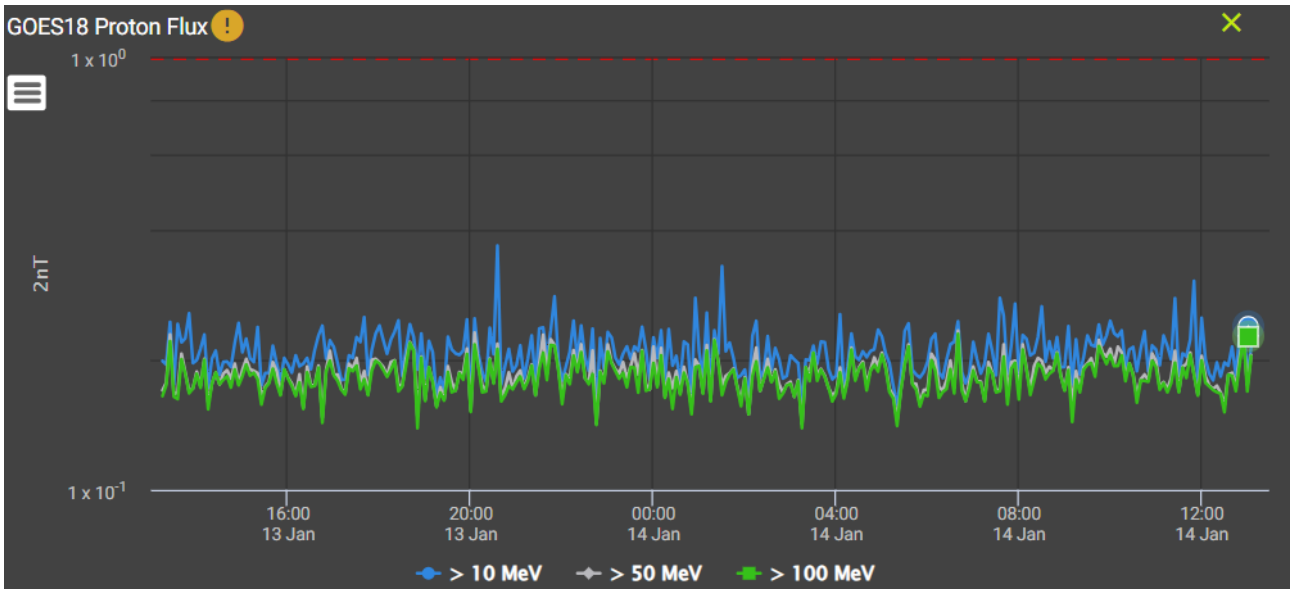
Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux is currently at background levels. Any further notable flares will bring a risk of proton flux rising, especially if they occur close to the western limb. Overall, there is a continuing slight chance of reaching the S1/Minor Radiation Storm threshold. With the probability maintained as a number of regions depart, whilst others rotate onto or across the visible disc.

Please note: GOES18 is currently being used as the primary proton instrument, with GOES16 data currently viewed as unreliable due to a fault reported by NOAA.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: 24 hour Proton trace



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High Energy Electrons Event (≥ 2MeV):

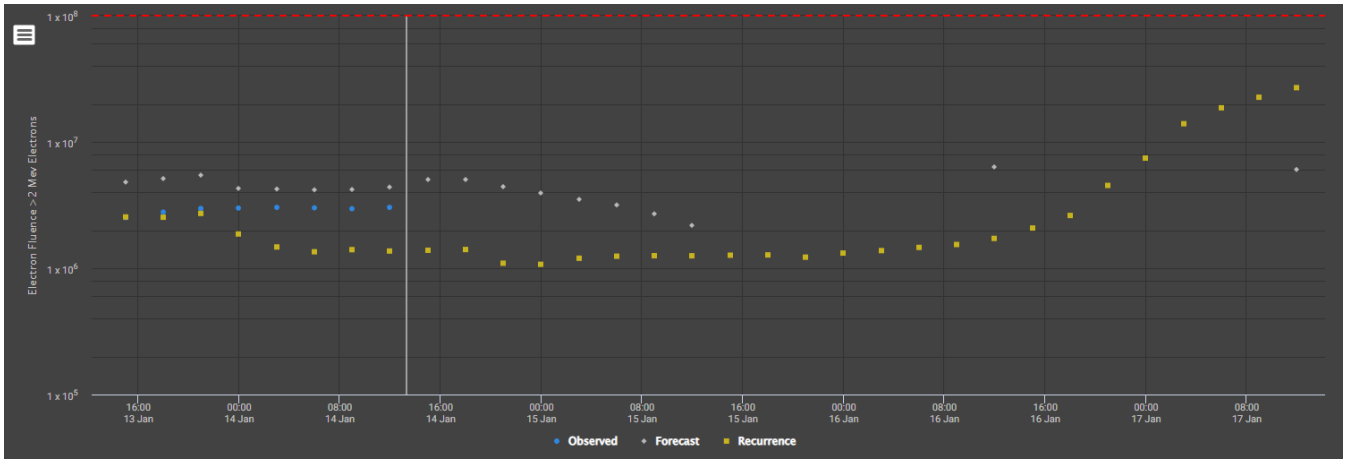
High energy electron flux (greater than 2MeV) as measured by GOES16 at GEO is currently at background levels, and in the absence of any significant enhancement is expected to persist at this level throughout much of the forecast period.

Connection to a coronal hole high speed stream may occur from late day 3 or day 4 (16-17 Jan), persisting until the end of the period, although any associated enhancement is not expected to produce any significant electron response until day 4 at the earliest.

MOSWOC REFM forecast values maintains fluence well below Active throughout the period, although the signal for a slight increase into day 4. This is considered good guidance. Recurrence would suggest fluence values may approach the Active level by the end of day 4 (17 Jan), however, the coronal hole is smaller and less pronounced and further East on this rotation so any enhancement is expected to be less significant and later than on the previous rotation.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	5
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM fluence forecast/observations/recurrance



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